



Human Reference Atlas Construction and Usage: The Breast

Katy Börner, Rachel Bajema, Ellen Quardokus, Heidi
Schlehlein, Indiana University, Bloomington, IN

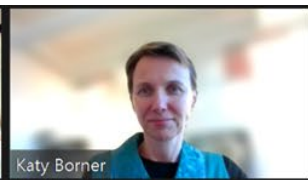
katy@iu.edu, rbajema@iu.edu, ellenmq@iu.edu,
hschleh@iu.edu

Presentation at LEAP - TNBC Breast Cancer Project, UCSD

November 30, 2022



Victoria Seewaldt (She, her)



Katy Borner



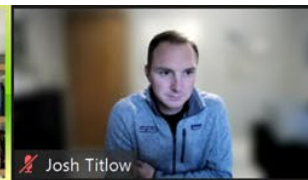
Tijana Jovanovic-Talisan



Jerneja



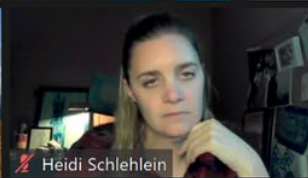
Shankar Subramaniam



Josh Titlow



Jason Swedlow



Heidi Schlehlein



Ellen Quardokus



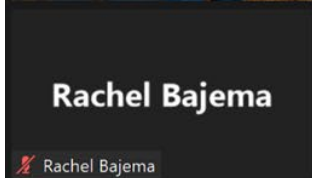
Sumana Srinivasan



fzcardif



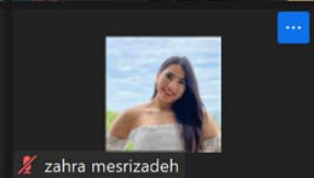
David Frankhouser



Rachel Bajema



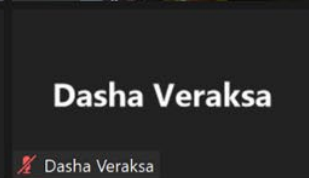
Augusto Ochoa



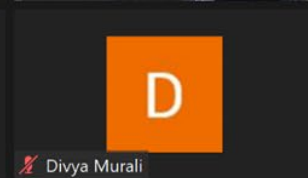
zahra mesrizadeh



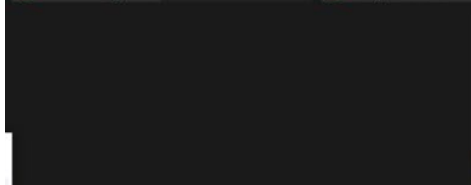
kavitha



Dasha Veraksa



Divya Murali



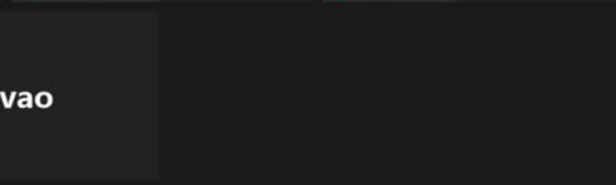
Jovanny Zabaleta

Jovanny Zabaleta



David Fooshee

David Fooshee



jalvao

jalvao



Outline

HuBMAP & The Human Reference Atlas

- Overview of project
- Human Reference Atlas effort

ASCT+B Tables

- Examples
- How to get involved

FTU Illustrations

- Examples
- How to contribute

3D Model

- Example/RUI
- How to contribute

Questions/Discussion



About HuBMAP



Vision

Catalyze the development of an open, global framework for comprehensively mapping the human body at cellular resolution.



HuBMAP

The Human BioMolecular Atlas Program

<https://commonfund.nih.gov/HuBMAP>

ACCELERATE TOOLS AND TECHNIQUE DEVELOPMENT

Accelerating the development of the next generation of tools and techniques for constructing high resolution spatial tissue maps that quantify multiple types of biomolecules either sequentially or simultaneously



GENERATE 3D HUMAN TISSUE MAPS

Generating foundational 3D human tissue maps using validated high-content, high-throughput imaging and omics assays

ESTABLISH OPEN DATA PLATFORM

Establishing an open data platform that will develop novel approaches to integrating, visualizing and modelling imaging and omics data to build multi-dimensional tissue maps, and making data rapidly findable, accessible, interoperable, and reusable by the global research community



COLLABORATE WITH THE RESEARCH COMMUNITY

Coordinating and collaborating with other funding agencies, programs, and the biomedical research community to build the framework and tools for mapping the human body at single cell resolution

SUPPORT PILOT PROJECTS

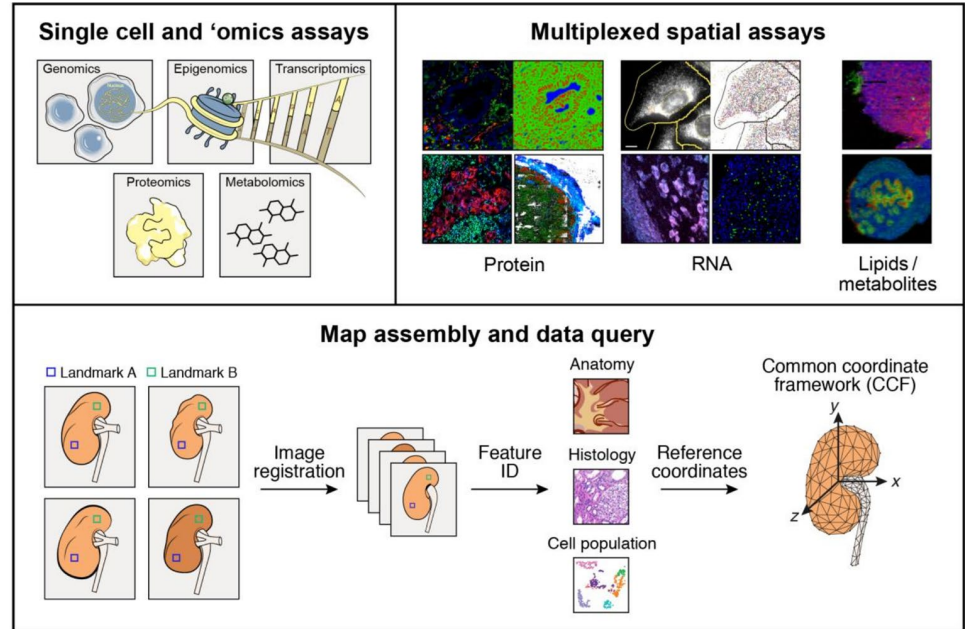
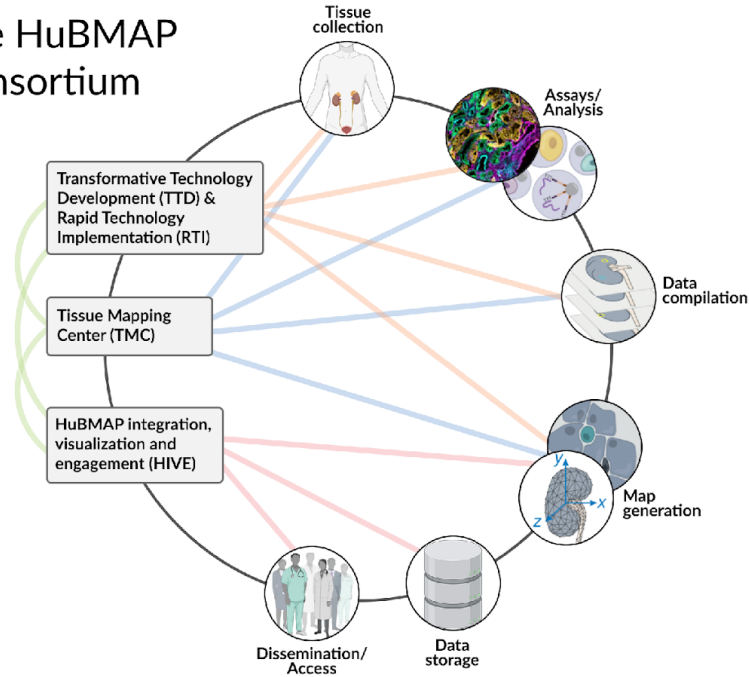
Supporting pilot projects that demonstrate the value of the resources developed by the program to study normal individual variations and tissue changes across the lifespan and the health-disease continuum



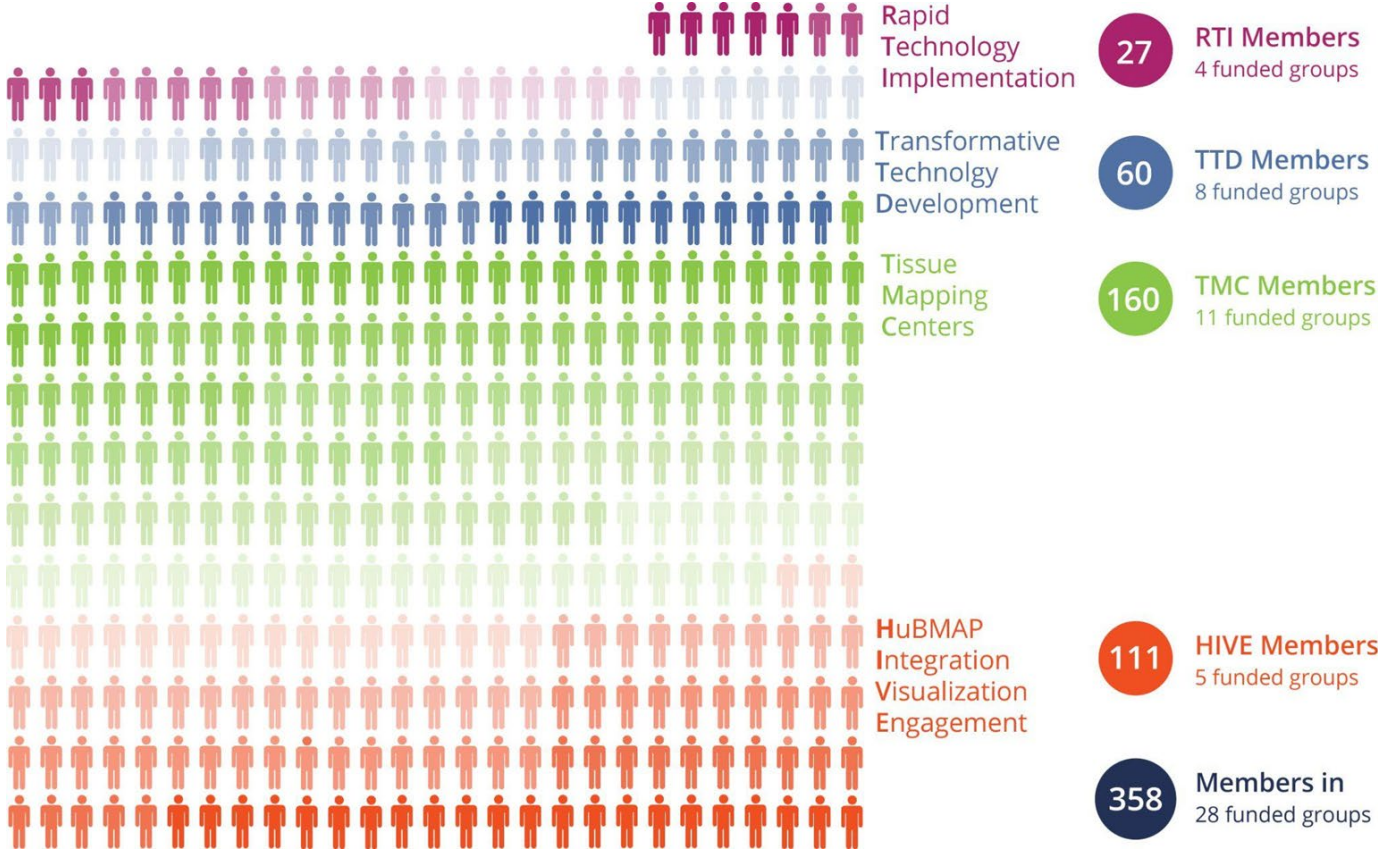
The Human Body at Cellular Resolution: The NIH Human Biomolecular Atlas Program

Snyder et al. *Nature*. 574, p. 187-192.

The HuBMAP Consortium



HuBMAP Funded Groups 2022



HuBMAP Contributing Sites

TMC, TTD
University of Washington
Pacific Northwest National Lab

RTI, TTD
Northwestern University

TMC
University of Iowa

HIVE - Mapping, RTI
New York Genome Center
GE Global Research
University of Rochester

NIH
Common Fund

TMC
Washington University, St. Louis
Washington University School of Medicine

TTD
Marquette University

 **SWITZERLAND**

TMC
University of Zurich

HIVE - Tools, TTD, RTI, TMC
Harvard University, Medical School
Broad Institute
Dana Farber Institute
Columbia University
Children's Hospital of Boston

 **NETHERLANDS**

TMC
Delft University of Technology

TMC, TTD
University of Connecticut
Yale University

HIVE - IEC, HIVE - Tools, RTI, TMC, TTD
Carnegie Mellon University
Pittsburgh Supercomputing Center
University of Pittsburgh
National Disease Research Interchange
Children's Hospital of Philadelphia
University of Pennsylvania
Pennsylvania State University

 **UNITED KINGDOM**

TMC, TTD, RTI, HIVE - TC
Stanford University,
University of California, Santa Cruz
University of California San Diego
California Institute of Technology
City of Hope National Medical Center

TMC
Vanderbilt University

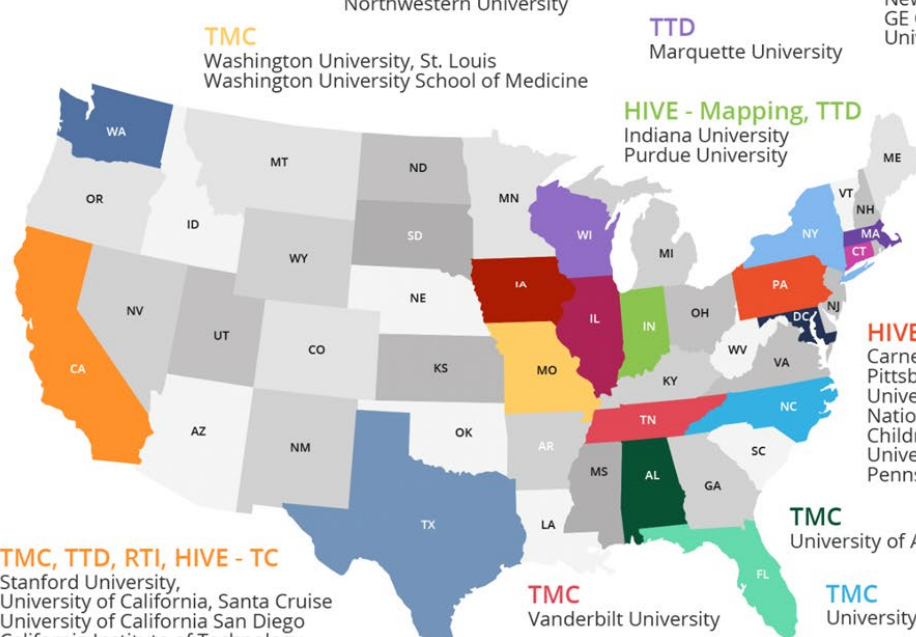
TMC
University of Alabama, Birmingham

TMC
University of North Carolina, Chapel Hill

TMC
Texas Advanced Computing Center

TMC
University of Florida

HIVE - Tools, TMC
European Bioinformatics Institute
Wellcome Sanger Institute



Setup and Scale Up Phase (2018-2022)

Tool Development

- Standardized Analytical Workflows, Metadata, Protocols
- Multimodal/Multi-scale data generation

3D Maps and Reference Datasets

- HRA Common Coordinate Framework
- ASCT+B & 3D Reference Object Library
- Azimuth

Open Data Platform

- HuBMAP Portal

Outreach and Collaboration

- Summer Internship Program, Jumpstart Program, Kaggle Competition

Production Phase (2022 - 2026)

3D Maps and Reference Datasets

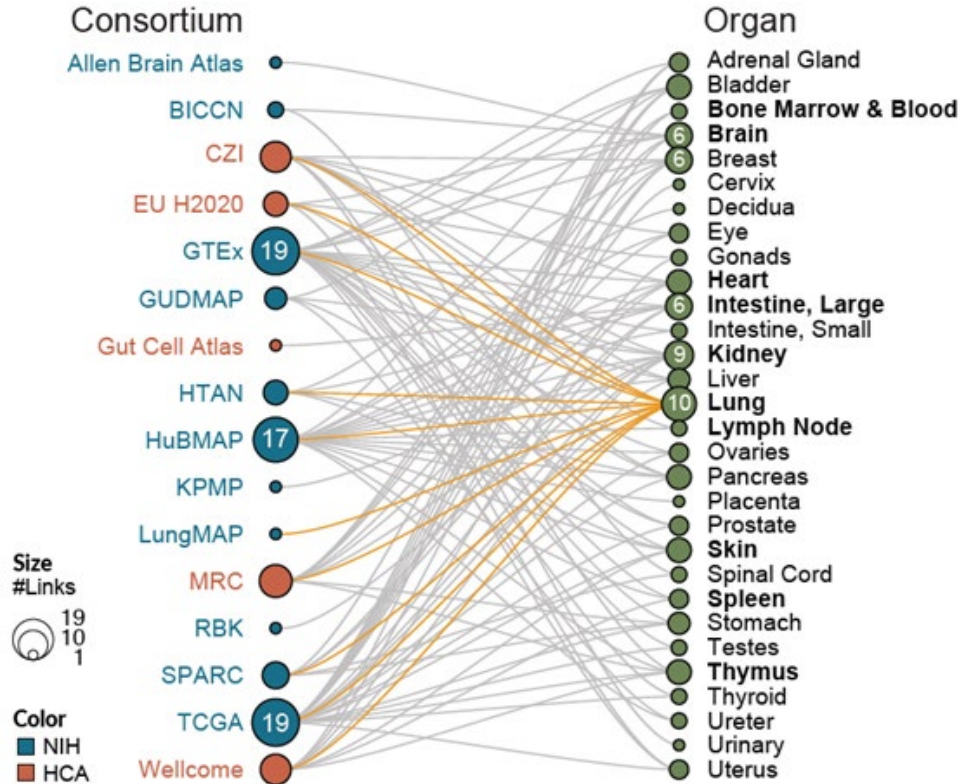
- Common data types: RNAseq, multiplexed IF, histology datasets
- Build bridging datasets to link data types, e.g., cell x gene data
- Azimuth maps for: kidney, lung, colon, bone marrow, female reproductive system, pancreas, heart, eye, skin, bone, and lymphatics
- Human Reference Atlas for 30 organs (ASCT+B Tables and associated 3D reference objects)
- Identify and generate 2D reference objects of FTUs at single cell level
- Build out Antibody Characterization / Validation Reports (AVRs) & Organ Mapping Antibody Panels (OMAPs)
- Crosswalk experimental data to the Human Reference Atlas



About Human Reference Atlas



Human Reference Atlas (HRA)



Börner, Katy, Sarah A Teichmann, Ellen M Quardokus, James Gee, Kristen Browne, David Osumi-Sutherland, Bruce W Herr II, Andreas Bueckle, Hrishikesh Paul, Muzlifah A Haniffa, Laura Jardine, Amy Bernard, Song-Lin Ding, Jeremy A Miller, Shin Lin, Marc Halushka, Avinash Boppana, Teri A Longacre, John Hickey, Yiing Lin, M Todd Valerius, Yongqun He, Gloria Pryhuber, Xin Sun, Marda Jorgensen, Andrea J Radtke, Clive Wasserfall, Fiona Ginty, Jonhan Ho, Joel Sunshine, Rebecca T Beuschel, Maigan Brusko, Sujin Lee, Rajeev Malhotra, Sanjay Jain, and Griffin Weber. 2021. "[Anatomical structures, cell types and biomarkers of the Human Reference Atlas](#)." *Nature Cell Biology* 23: 1117-1128. doi: 10.1038/s41556-021-00788-6.

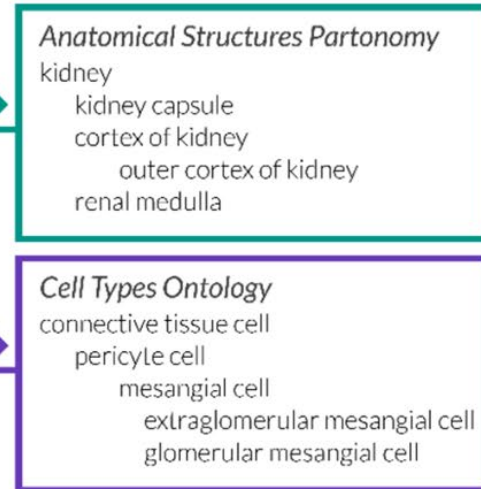
Human Reference Atlas (HRA)

Anatomical Structures, Cell Types, and Biomarkers or ASCT+B tables aim to capture the partonomy of anatomical structures, cell types, and major biomarkers (e.g., gene, protein, lipid or metabolic markers). 3D and 2D reference object capture the shape, size, and spatial composition of ASCT.

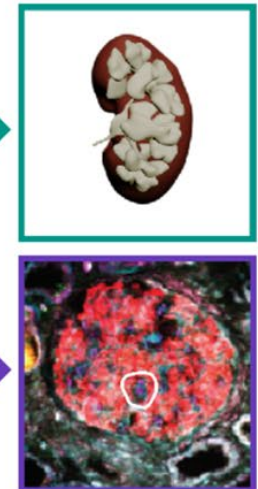
ASCT Table

Structure/Region	Sub structure/Sub region	Cell Type
Renal Corpuscle	Bowman's (glomerular) Capsule/parietal layer	Parietal epithelial Cell
	Bowman's (glomerular) Capsule/visceral layer	Podocyte
	Glomerular Tuft	Capillary Endothelial Cell Mesangial Cell
Tubules	Proximal Tubule	Proximal Tubule Epithelial Cell (general)
		Proximal Convoluted Tubule Epithelial Cell Segment 1
		Proximal Tubule Epithelial Cell Segment 2
		Proximal Tubule Epithelial Cell Segment 2
		Proximal Tubule Epithelial Cell Segment 2
	Loop of Henle, Thin Limb	Descending Thin Limb Cell (general)
	Loop of Henle, Thick Limb	Ascending Thin Limb Cell (general)
		Thick Ascending Limb Cell (general)
	Distal Convolution	Cortex-TAL Cell
		Medulla-TAL Cell
		TAL-Macula Densa Cell
	Connecting Tubule	Distal Convoluted Tubule Cell (general)
		DCT Type 1 Cell
DCT Type 2 Cell		
Connecting Tubule Cell (general)		
		CNT-Principal Cell

Ontology

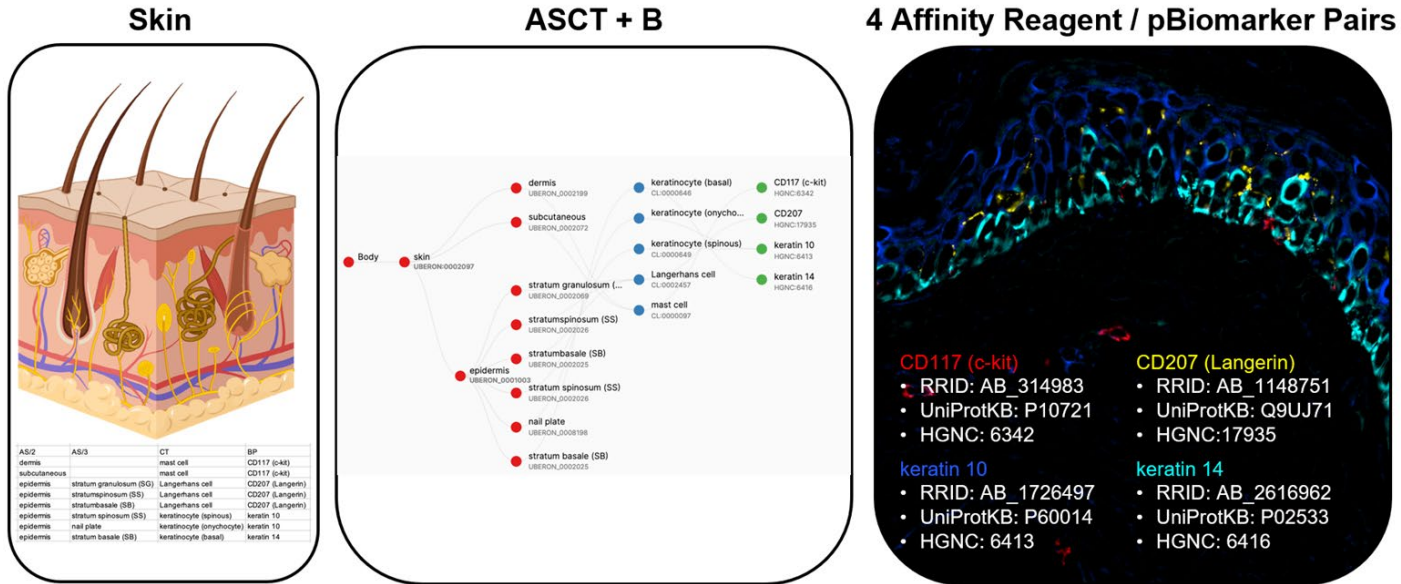


3D Reference Object Library

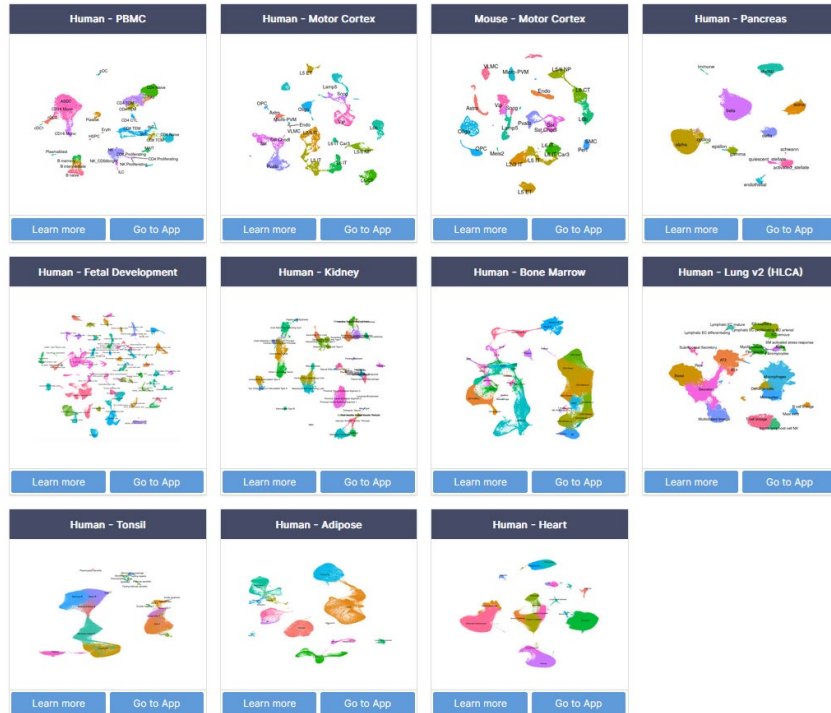


Human Reference Atlas (HRA)

Organ Mapping Antibody Panels (OMAPs) are collections of antibodies that allow spatial mapping of the anatomical structures and cell types present in diverse organs using multiplexed antibody-based imaging.



Azimuth References



Azimuth is a web application that uses an annotated reference dataset to **automate the processing, analysis, and interpretation of a new single-cell RNA-seq experiment.**

Azimuth leverages a '**reference-based mapping**' pipeline that inputs a counts matrix of gene expression in single cells, and performs normalization, visualization, cell annotation, and differential expression (biomarker discovery). All results can be explored within the app, and easily downloaded for additional downstream analysis.

<https://azimuth.hubmapconsortium.org>

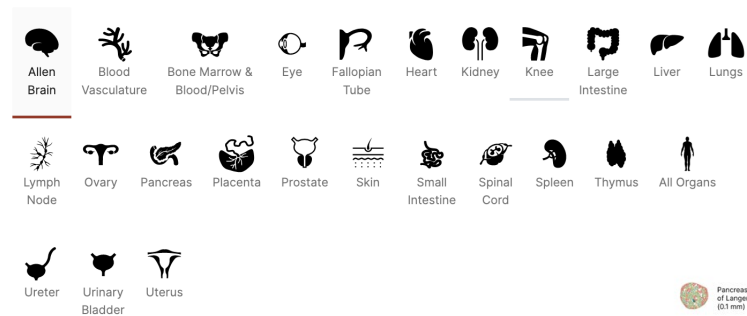
The development of Azimuth is led by the New York Genome Center Mapping Component as part of the [NIH Human Biomolecular Atlas Project \(HuBMAP\)](#).

Human Reference Atlas (HRA) v1.3

ASCT+B Tables: 26 tables

Organ	#AS	#CT	#B Total	#BG	#BP	#AS-AS	#AS-CT	#CT-B
Blood	1	30	159	112	47	1	30	506
Blood Vasculature	918	10	10	10	0	952	2030	11
Bone Marrow	1	47	262	198	64	1	47	838
Brain	183	127	257	257	0	183	127	346
Eye	26	53	140	61	75	27	58	404
Fallopian Tube	72	18	26	13	13	84	81	27
Heart	50	23	45	45	0	60	183	74
Kidney	57	67	184	184	0	72	75	300
Knee	33	41	12	0	12	33	21	47
Large Intestine	54	57	166	83	83	287	1156	360
Liver	17	31	85	29	56	17	32	116
Lung	76	76	280	191	89	121	168	456
Lymph Node	34	45	223	106	117	43	86	499
Lymph Vasculature	31	1	1	1	0	31	19	1
Ovary	77	16	12	0	12	126	30	11
Pancreas	32	34	51	49	2	153	228	126
Peripheral Nervous System	782	1	2	1	1	803	609	2
Placenta	25	22	44	43	0	32	44	74
Prostate	4	12	31	31	0	4	12	36
Skin	15	36	70	0	70	17	19	100
Small Intestine	39	48	89	43	46	69	178	131
Spleen	37	60	194	85	109	50	129	421
Thymus	17	51	394	318	76	28	39	603
Ureter	7	14	30	30	0	7	14	61
Urinary Bladder	16	15	30	30	0	16	16	63
Uterus	61	18	45	39	6	89	34	65
Totals:	2,665	953	2,842	1,959	878	3,306	5,465	5,678

3D Reference Object Library: 57 organ models, landmark organs, 2 united files, adding L/R breast (mammary gland)



All available via HRA Portal

<https://hubmapconsortium.github.io/ccf>

HRA User Interfaces/Training

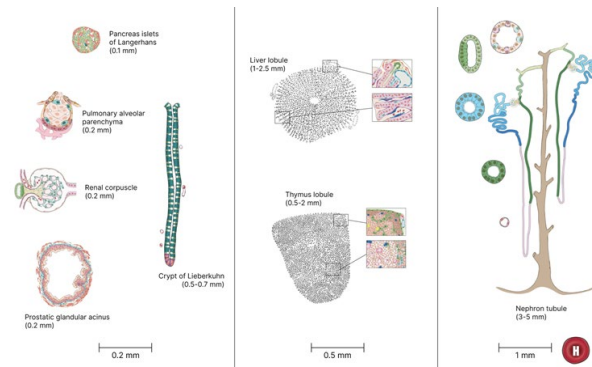
- ASCT+B Reporter
- Registration User Interface (RUI)
- Exploration User Interface (EUI)
- Visible Human MOOC (VHMOOC)

2D FTUs: 19 FTUs

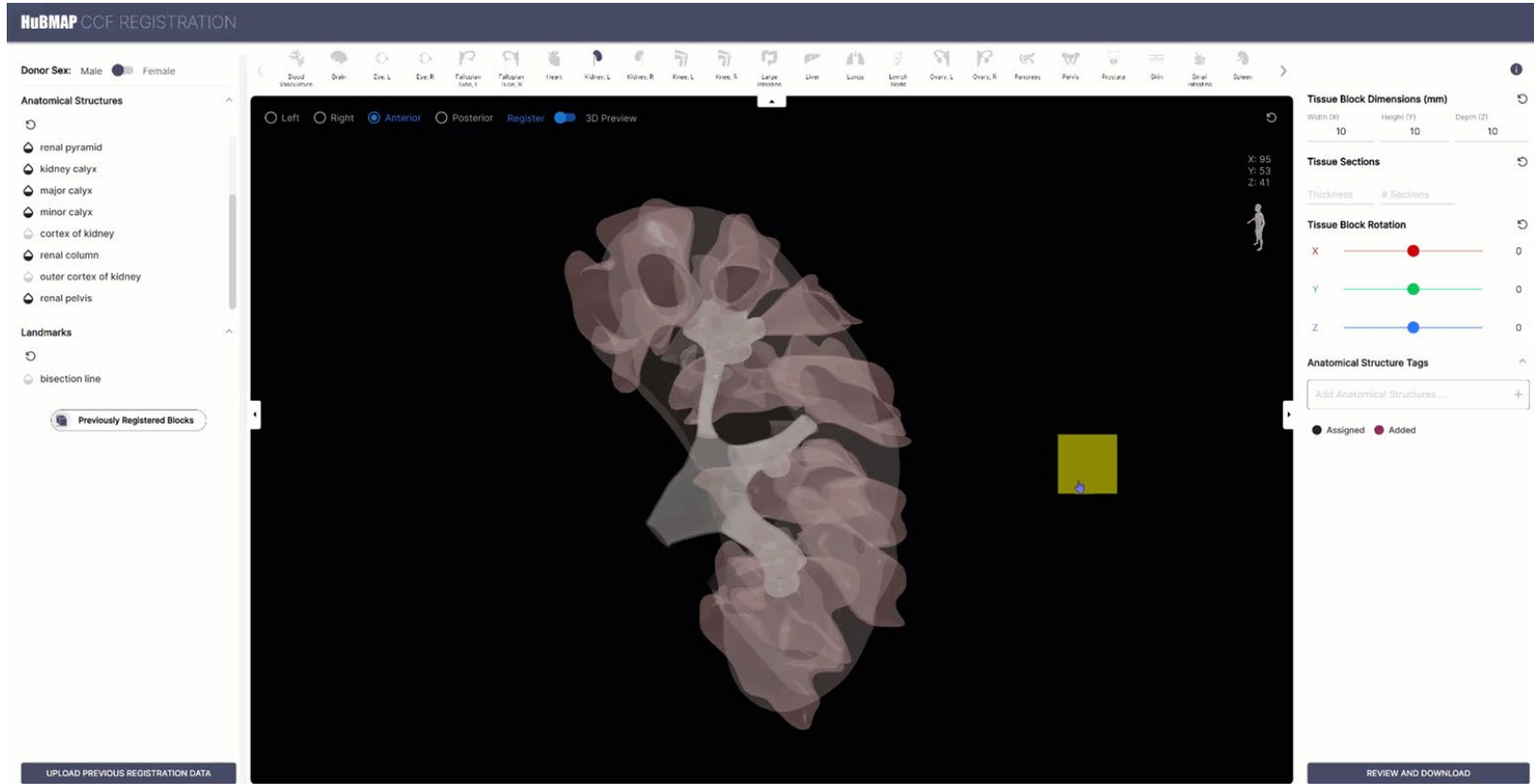
OMAPs: 8 organs

References to papers

21 References to data via Kidney Azimuth from Blue Lake et al. paper with 21 tissue blocks



Registration User Interface (RUI)



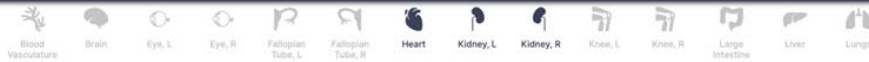
<https://hubmapconsortium.github.io/ccf-ui/rui/>

Exploration User Interface (EUI)

HuBMAP CCF EXPLORATION

LOGIN

Sex: Both Age: 1-110 BMI: 13-83

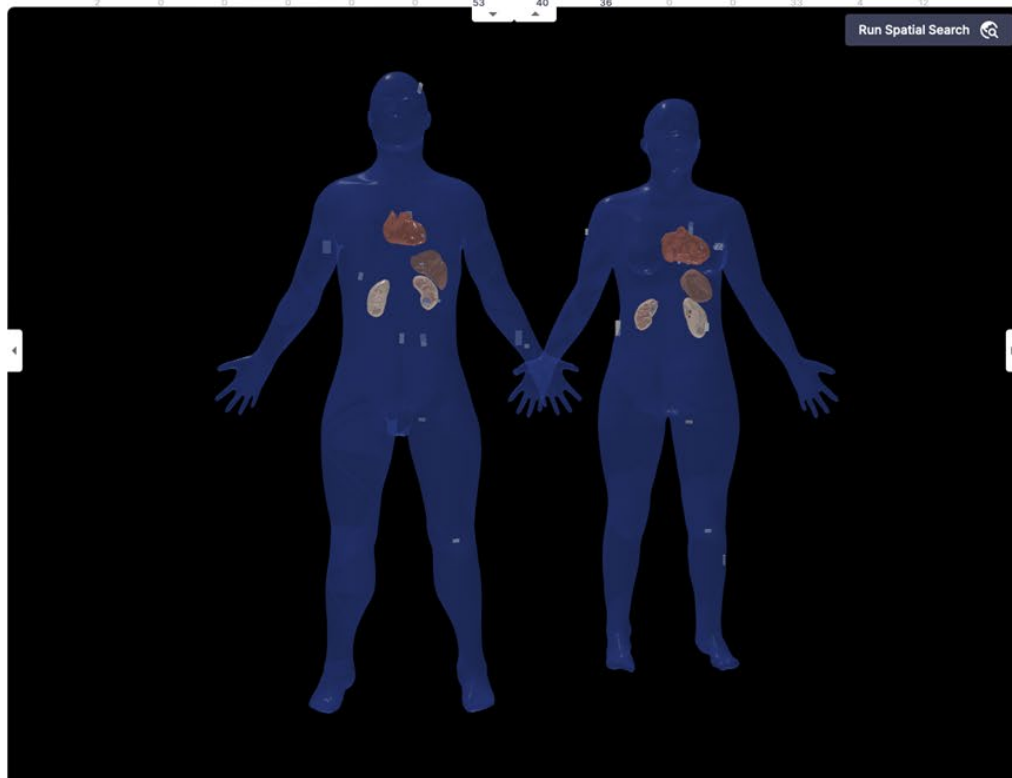


Search anatomical structures...

body	377
brain	0
lymph node	33
eye	0
fallopian tube	0
heart	53
kidney	76
knee	0
liver	4
lung	11
ovary	1
pancreas	4
pelvis	0

Search cell types...

cell	377
absorptive	43
adventitial stromal cell	67
afferent neuron cell	4
airway deuterosomal cell	12
alveolar type 1 fibroblast	12
alveolar type 2 fibroblast	12
amnion mesenchymal stromal cell (amsc)	0
apocrine cell	33
articular chondrocyte	0
astro il1 fgfr3 serpin12 primary motor cortex	0
astro il-6 fgfr3 aqp1 primary motor cortex	0
astro il-6 fafr3 plca1 primary motor cortex	0



body | cell

9	Tissue Data Providers
146	Donors
377	Tissue Blocks
622	Tissue Sections
1286	Tissue Datasets

- Apical Septum Female
Entered 3/16/2021, Peter Hanna, SPARC/UCLA
- Basal Right Ventricle Free Wall Female
Entered 3/16/2021, Peter Hanna, SPARC/UCLA
- Basal Septum Left Ventricle Female
Entered 3/16/2021, Peter Hanna, SPARC/UCLA
- Basal Septum Left Ventricle Male
Entered 3/16/2021, Peter Hanna, SPARC/UCLA
- Left Ventricle Apex Female
Entered 3/16/2021, Peter Hanna, SPARC/UCLA
- Left Ventricle Apex Male
Entered 3/16/2021, Peter Hanna, SPARC/UCLA
- Middle Anterior Left Ventricle Female
Entered 3/16/2021, Peter Hanna, SPARC/UCLA
- Middle Anterior Left Ventricle Male
Entered 3/16/2021, Peter Hanna, SPARC/UCLA
- Middle Lateral Left Ventricle Female
Entered 3/16/2021, Peter Hanna, SPARC/UCLA
- Middle Lateral Left Ventricle Male
Entered 3/16/2021, Peter Hanna, SPARC/UCLA
- Middle posterior Left Ventricle Female
Entered 3/16/2021, Peter Hanna, SPARC/UCLA
- Apical Septum Male
Entered 3/16/2021, Peter Hanna, SPARC/UCLA
- Middle posterior Left Ventricle Male
Entered 3/16/2021, Peter Hanna, SPARC/UCLA
- Middle Septum Female
Entered 3/16/2021, Peter Hanna, SPARC/UCLA

<https://portal.hubmapconsortium.org/ccf-eui>

Exploration User Interface (EUI)

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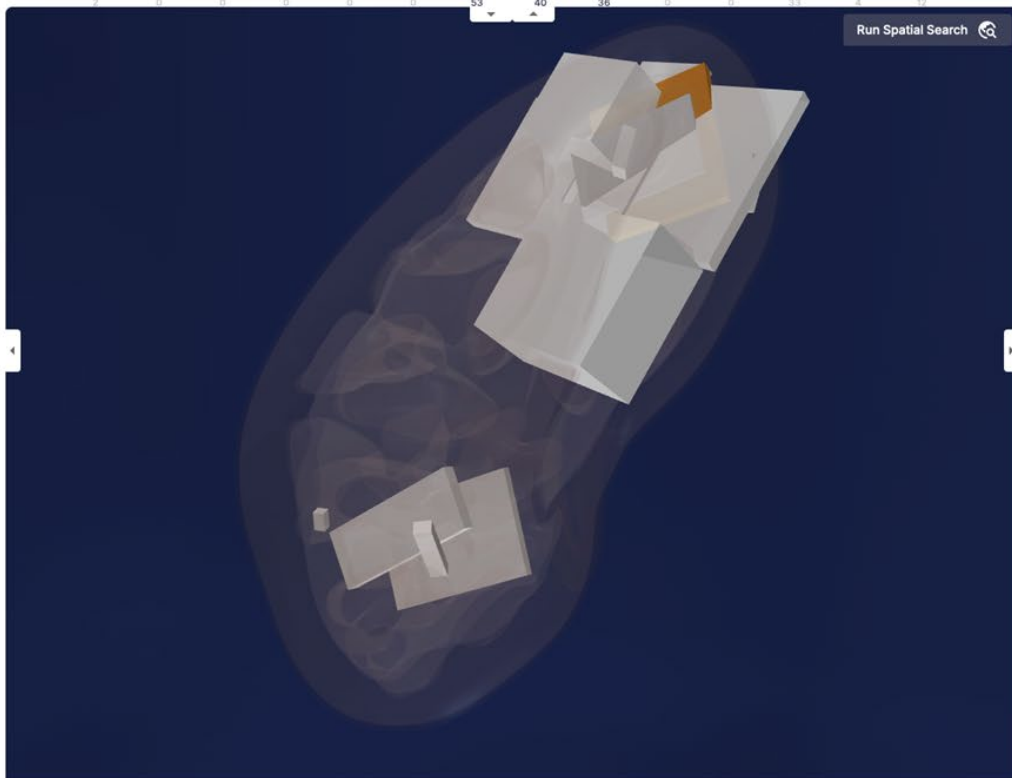


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body | cell

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Female, Age 44, BMI 28.0
Entered 12/26/2019, Jamie Allen, TMC-Vande... ^

Registered 6/10/2020, Jamie Allen, TMC-Van...
17 x 18 x 3 millimeter, 1.5 millimeter, fresh_fro...
0 |-----| 2

MALDI MALDI PAS AF P

Registered 12/27/2019, Jamie Allen, TMC-Van...
17 x 18 x 1.5 millimeter, 1.5 millimeter, fresh...
Registered 12/27/2019, Jamie Allen, TMC-Van...
17 x 18 x 1.5 millimeter, 1.5 millimeter, fresh...

Female, Age 44, BMI 28.0
Entered 12/26/2019, Jamie Allen, TMC-Vande... ^

Registered 6/10/2020, Jamie Allen, TMC-Van...
17 x 18 x 3 millimeter, 1.5 millimeter, fresh_fro...
0 |-----| 2

OTHER PAS PAS OTHER

Registered 11/10/2020, Jamie Allen, TMC-Van...
17 x 18 x 1.5 millimeter, 1.5 millimeter, fresh...
Registered 11/10/2020, Jamie Allen, TMC-Van...
17 x 18 x 1.5 millimeter, 1.5 millimeter, fresh...

Apical Septum Female
Entered 3/16/2021, Peter Hanna, SPARC/UCLA

Basal Right Ventricle Free Wall Female
Entered 3/16/2021, Peter Hanna, SPARC/UCLA

Basal Septum Left Ventricle Female

Exploration User Interface (EUI) - Spatial Search

HuBMAP CCF EXPLORATION

LOGIN

Sex: Both Age: 1-110 BMI: 13-83



Search anatomical structures...

- body 377
 - brain 0
 - lymph node 33
 - eye 0
 - fallopian tube 0
 - heart 53
 - kidney 76
 - knee 0
 - liver 4
 - lung 11
 - ovary 1
 - pancreas 4
 - pelvis 0

Search cell types...

- cell 377
 - absorptive 43
 - adventitial stromal cell 67
 - afferent neuron cell 4
 - airway deuterosomal cell 12
 - alveolar type 1 fibroblast 12
 - alveolar type 2 fibroblast 12
 - amion mesenchymal stromal cell (amsc) 0
 - apocrine cell 33
 - articular chondrocyte 0
 - astro I1 fgfr3 serpin2 primary motor cortex 0
 - astro I1-6 fgfr3 aqp1 primary motor cortex 0
 - astro I1-6 fafr3 plca1 primary motor cortex 0

Run Spatial Search

Configure Spatial Search

Donor Sex: Female Organ: Kidney, L Edit

Probing Sphere Radius: 6 mm

Reset Probing Sphere Reset Camera View

0 Tissue Blocks

0 Anatomical Structures

0 Predicted Cell Types from ASCI+6 Tables

Run Spatial Search

Use the keyboard or click a Tissue Block to move the Probing Sphere

X: 65 Y: 38 Z: 39

body | cell

9 Tissue Data Providers

146 Donors

377 Tissue Blocks

622 Tissue Sections

1286 Tissue Datasets

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Basal Right Ventricle Free Wall Female

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Basal Septum Left Ventricle Female

Exploration User Interface (EUI) & Vitecssce

HuBMAP CCF EXPLORATION

Open in Portal

HuBMAP Donors Samples Datasets Other Atlas & Tools Resources User Profile

HBM645.ZQSN.258 Kidney (Right) MALDI IMS

Sections

- Summary
- Visualization
- Provenance
- Metadata
- Files
- Collections
- Contributors
- Attribution

MALDI Imaging MS data collected from the Right Kidney of a 44 year old White Female donor by the Biomolecular Multimodal Imaging Center (BIOMIC) at Vanderbilt University. BIOMIC is a Tissue Mapping Center that is part of the NIH funded Human Biomolecular Atlas Program (HuBMAP). Mass Spectrometry images of Lipids were collected with a Bruker Daltonics MALDI timsTOF Flex Prototype at 10 m from m/z 100-2000 in Positive Ion Mode. Support was provided by the NIH Common Fund and National Institute of Diabetes and Digestive and Kidney Diseases (U54 DK120058). Tissue was collected through the Cooperative Human Tissue Network with support provided by the NIH National Cancer Institute (5 UMI CA183727-08).

Publication Date: 2020-09-08 Modification Date: 2022-02-11

Visualization

Spatial Layers

- 700.564 CerP(d40) [checked]
- 701.512 PA(36:1)-t [checked]
- 718.538 PE(34:0)- [checked]
- 707.501 PA(O-38:E) [checked]
- 700.564 CerP(d40) [unchecked]

Data Set

- VAN0012-RK-103-75-IMS_NegMode_multilayer.ome.tif

body | cell

- 9 Tissue Data Providers
- 146 Donors
- 377 Tissue Blocks
- 622 Tissue Sections
- 1286 Tissue Datasets

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- Registered 12/27/2019, Jamie Allen, TMC-... 17 x 18 x 1.5 millimeter, 1.5 millimeter, fresh...
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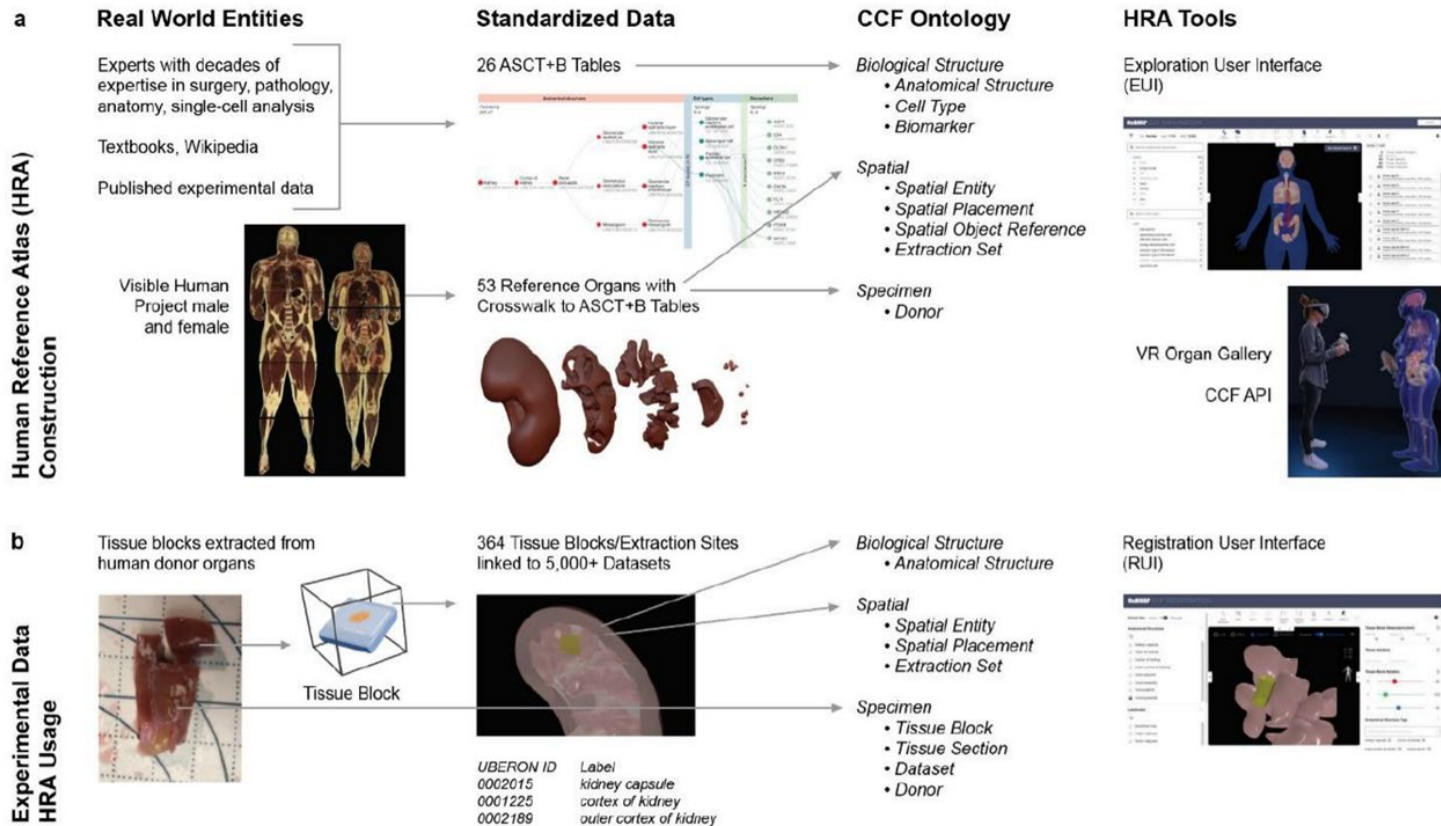
- Registered 6/10/2020, Jamie Allen, TMC-Van... 17 x 18 x 3 millimeter, 1.5 millimeter, fresh...
- Registered 11/10/2020, Jamie Allen, TMC-... 17 x 18 x 1.5 millimeter, 1.5 millimeter, fresh...
- Registered 11/10/2020, Jamie Allen, TMC-... 17 x 18 x 1.5 millimeter, 1.5 millimeter, fresh...

Apical Septum Female
Entered 3/16/2021, Peter Hanna, SPARC/UCLA

Basal Right Ventricle Free Wall Female
Entered 3/16/2021, Peter Hanna, SPARC/UCLA

Basal Septum Left Ventricle Female

<https://portal.hubmapconsortium.org/ccf-eui>



Specimen,
 Biological Structure,
 and Spatial
 Ontologies in
 Support of a Human
 Reference Atlas

<https://biorxiv.org/content/short/2022.09.08.507220v1>

Figure 1. From real-world entities, to standardized data, to ontology. a. Human Reference Atlas construction takes real-world data and represents it in standardized data structures that are defined by the interlinked Biological Structure, Spatial, and Specimen ontologies.



ASCT+B Tables



Breast ASCT+B Table

Goals and objectives

Capture relationships between Anatomical structures (AS), cell types (CT) and biomarker (B) sets that uniquely define those cell types for Breast

- Anatomical structures: gross, macro and microscopic levels
- Cell types present in each of the anatomical structures
- Biomarker sets that uniquely define a cell type for cell type annotation
- Proteins (proteoforms, transcription factors etc), single cell transcriptomics differentially expressed genes, metabolites, lipids, spatial transcriptomics, multi-omic (CITE-seq)
- Map all AS, CT, Biomarker types to standard ontologies (uberon, cell ontology, HGNC, UniProt, LipidMaps, METLIN and Human Metabolome Databases)
- Working with Harikrishna Nakshatri from Indiana University School of Medicine and Susan G. Komen Tissue Bank at IU Simon Comprehensive Cancer Center for spatial transcriptomics and transcriptomics



FTU Illustrations

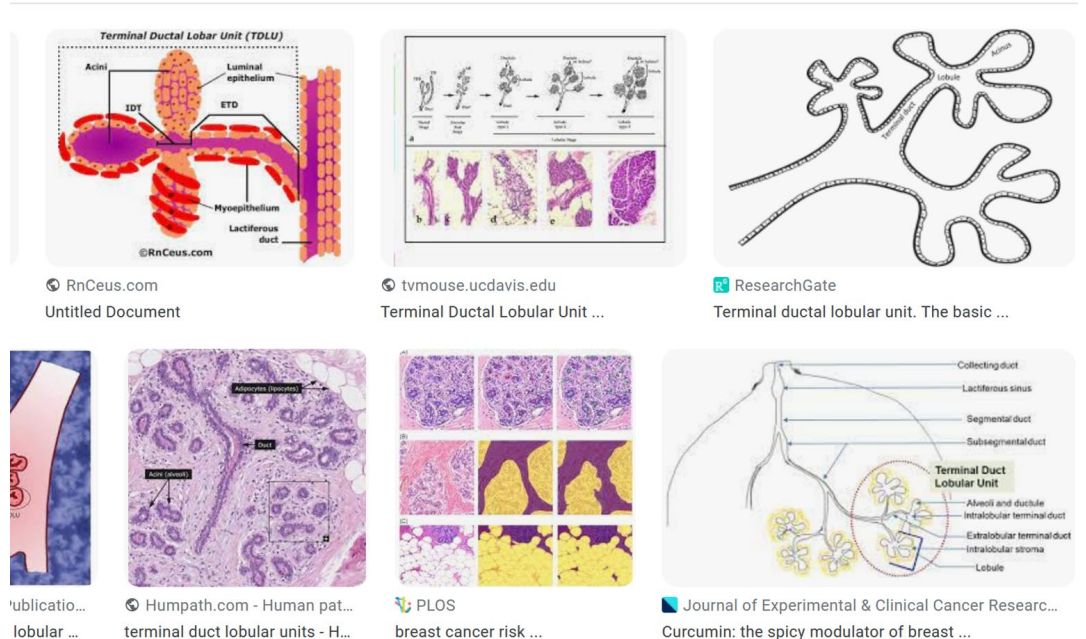


Breast 2D Functional Tissue Units (FTUs)

Illustrate functional tissue unit(s) for breast. Currently published as static images on the CCF portal. Next cycle published with interactive functionality, linked to data.

Potential FTUs for Breast:

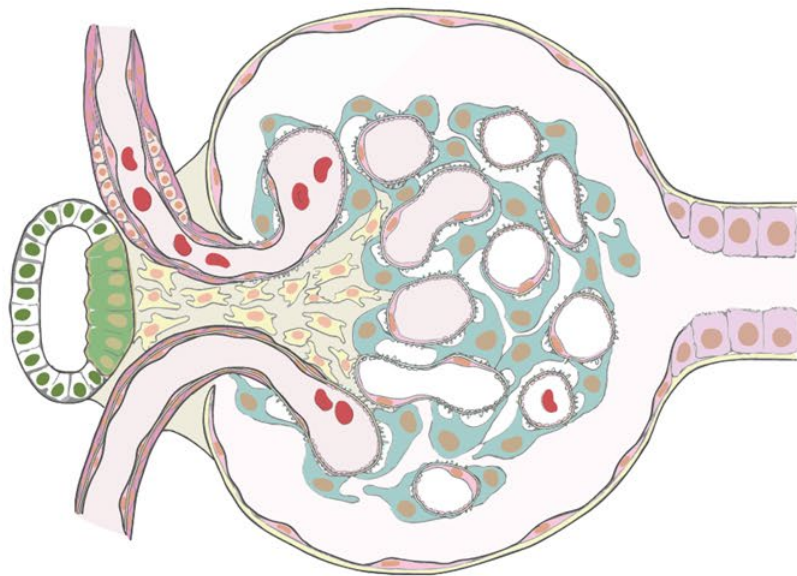
- *Terminal duct lobular unit (TDLU)*
- Acinus
- Lactiferous sinus
- Segmental duct



FTU Library

Renal Corpuscle of the Kidney

- ^ Kidney
 - Ascending thin limb
 - Cortical collecting duct
 - Collecting duct (inner medulla)
 - Collecting duct (outer medulla)
 - Descending thin limb
 - Nephron
 - Renal corpuscle**
- ^ Large intestine
 - Crypt of Lieberkuhn
- ^ Liver
 - Liver lobule
- ^ Lung
 - Pulmonary alveolar parenchyma
 - Bronchial submucosal gland
- ^ Pancreas
 - Acinus
 - Intercalated duct
 - Islets of Langerhans
- ^ Prostate
 - Prostatic glandular acinus
- ^ Skin
 - Dermal papilla
 - Epidermal ridge
- ^ Spleen
 - Red pulp
 - White pulp
- ^ Thymus
 - Thymus lobule



50 μ m

Illustration Embed

Cell Types by Gene Biomarkers [Expand](#)

Gene Biomarkers	Protein Biomarkers	Lipid Biomarkers	
Cell Type	Cell Count	VCAM1	CLDN1
parietal epithelial cell	5,758	●	●
glomerular visceral epithelial cell	13,224		
glomerular capillary endothelial cell	2,028		
glomerular mesangial cell	no data		
Gene Expression Mean in FTU	Percentage of cells in FTU		

Source Data

1. Kidney Precision Medicine Project
[Ancillary Study Data, Clinical Data, HRT Codebook](#)
2. [Dataset Owner Title]
[<Dataset Title + Link to Dataset>](#)
3. [Dataset Owner Title]
[<Dataset Title + Link to Dataset>](#)
4. [Dataset Owner Title but extremely long and wraps around to the next line as you can see here in this example]
[<Extremely long dataset title that wraps around to the next line as you can see in this example + link to dataset>](#)
5. [Dataset Owner Title]
[<Dataset Title + Link to Dataset>](#)
6. [Dataset Owner Title]

Contact HRA Portal



3D model of breast



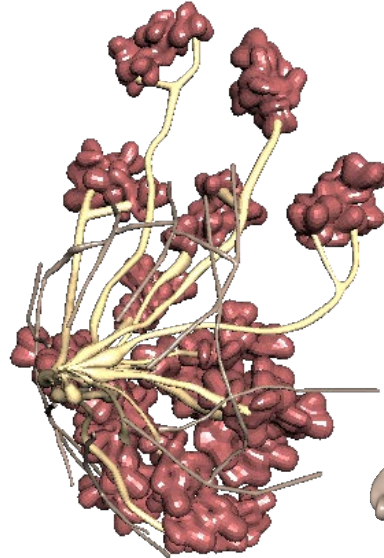
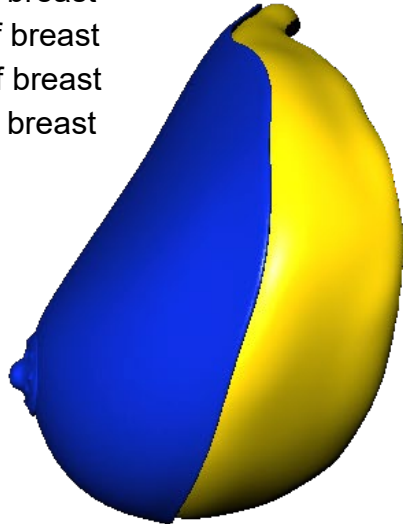
Human female mammary gland model

Created for use in Registration User Interface (RUI)

List of Anatomic Structures

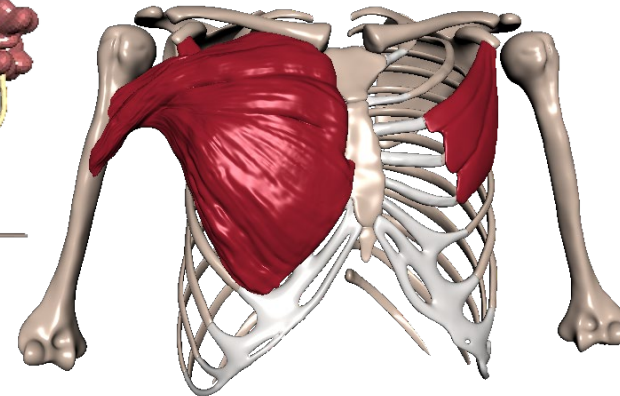
Mammary gland (F):

- lower inner quadrant of breast
- lower outer quadrant of breast
- upper inner quadrant of breast
- upper outer quadrant of breast
- suspensory ligament of breast
- axillary tail of breast
- mammary lobes
- areolar tubercle
- main lactiferous duct
- lactiferous sinus
- fat pads
- nipples
- areolas



Landmarks (F):

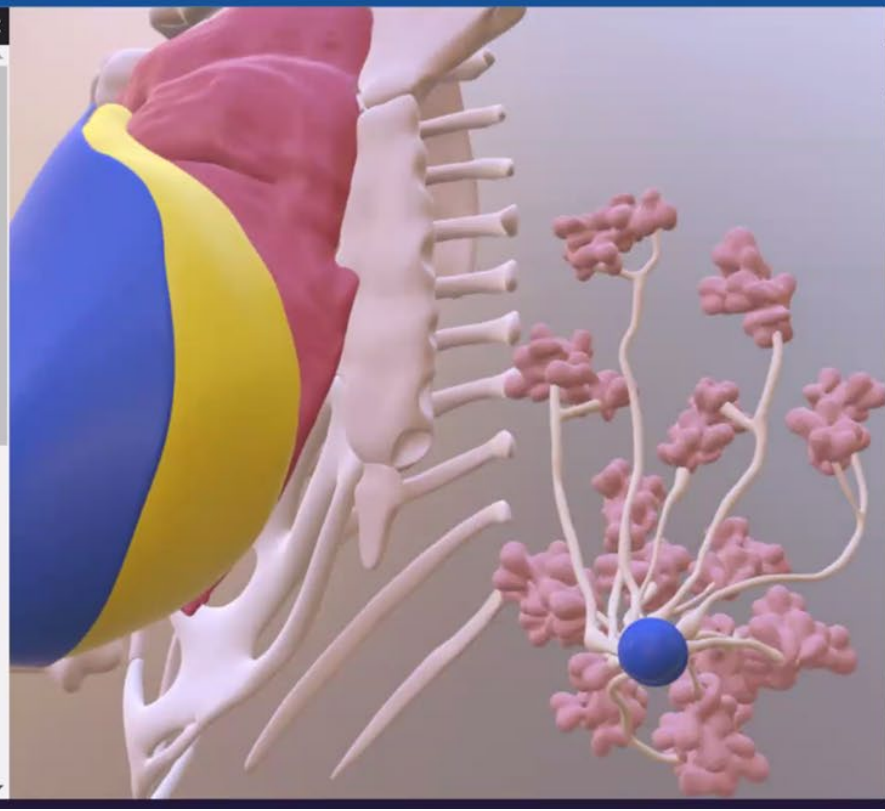
- manubrium, sternum, xiphoid process
- pectoralis major (2)
- Pectoralis minor (2)
- Clavicles (2)
- Humerus (2)
- Ribs (2x12)
- Costal cartilage (2x6)



SCENE EXPLORER

Filter

- Scene
 - Nodes
 - _root_
 - VH_F_mammary_gland_L
 - VH_F_areola_L
 - VH_F_areolar_tubercles_L
 - VH_F_fat_L
 - VH_F_main_lactiferous_ducts_L**
 - VH_F_main_lactiferous_sinuses_L
 - VH_F_mammary_lobes_L
 - VH_F_nipple_L
 - VH_F_suspensory_ligaments_L
 - VH_F_mammary_gland_landmarks
 - VH_F_mammary_gland_L_landmarks
 - VH_F_mammary_gland_L_landmark_axillary_tail...
 - VH_F_mammary_gland_L_landmark_clavicle
 - VH_F_mammary_gland_L_landmark_costal_cart...
 - VH_F_mammary_gland_L_landmark_humerus
 - VH_F_mammary_gland_L_landmark_lower_inne...
 - VH_F_mammary_gland_L_landmark_lower_oute...
 - VH_F_mammary_gland_L_landmark_manubrium
 - VH_F_mammary_gland_L_landmark_pectoralis_...
 - VH_F_mammary_gland_L_landmark_pectoralis_...
 - VH_F_mammary_gland_L_landmark_ribs



INSPECTOR

GENERAL

ID VH_F_main_lactiferous_duct...

Name **VH_F_main_lactife**

Unique ID 17

Class Mesh

Vertices 69517

Faces 34755

Sub-meshes 1

Link to parent VH_F_mammary_gl...

Parent **VH_F_mammai**

Is enabled

Is pickable

Link to material gland_mat

Active material **gland_mat**

Dispose

TRANSFORMS

Position X: 0.00, Y: 0.00, Z: 0.00 +

Rotation (Using C) X: 0.00, Y: 0.00, Z: 0.00 +



Questions / Discussion

